Quality 4.0 Implementation to Reduce Customer Complaints on Plastic Packaging Products in the Manufacturing Industry

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Abstract. The industrial revolution 4.0 is currently a topic that is often discussed in the industrial world. Presentation of data that can be accessed quickly makes everyone must immediately respond to any changes that occur in their work area. Quality 4.0 is in line with the development of industrial digitization by using advanced technology to improve the quality of manufacturing and services. In the midst of very tight competition, especially in the plastic packaging industry, every company must be able to innovate in its production process and must be able to reduce customer complaints. The purpose of this study is to apply industrial technology 4.0 in the quality sector to reduce customer complaints. The method used is Quality 4.0. The application of Quality 4.0 can identify several factors that cause product packaging not to suit customer desires. Inappropriate product appearance and function can be corrected by implementing Quality 4.0 with a clean room and strict process control. The research results can reduce customer complaints by 44% in 2020 and 27% in 2021.

Keyword: Dashboard; Digitalization; Packaging Plastic; Quality 4.0

1 Introduction

Industry 4.0 is one of the eras of automation which began in 2011 in Germany. This era is a development of the previous era, namely the 1.0, 2.0 and 3.0 revolutions. This era is an era that is recommended by academics, researchers, associations, practitioners and the German government who work together to achieve a competitive manufacturing industry. Through I4.0, Germany became the leading country in the development of I4.0 in the world. The entry into the 4.0 era has a goal, namely to help mankind in all aspects, so that it becomes easier for humans. The three previous revolutions, the way humans work still relies on muscle strength. In contrast, the Industrial Revolution 4.0 appeared to carry out brain functions for mankind. It can be explained that the concepts and methods offered use a set of sophisticated technologies that are integrated by all process elements. The emergence of the Industrial Revolution 4.0 is marked by the processing capabilities of cyber physical systems. [1].

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To continue to improve the quality of industry in Indonesia, the Indonesian Ministry of Industry continues to strive to implement Industry 4.0 in the upstream and downstream industries. The steps taken are by appointing several types of industries as pilot projects using the Smart Factory concept. This must be utilized properly by every company in changing the work pattern that initially used a lot of paper to become an integrated digitalization system. The use of paper has been greatly reduced and replaced by a system so that all requests can be made directly through the system via a computer or mobile phone [2]. The Ministry of Industry has identified and selected seven sectors based on their impact and ease of implementation of industrial technology (can be seen in Table 1). These sectors were chosen because they accounted for 70 percent of industrial GDP, 65 percent of industrial exports, and 60 percent of the workforce in the manufacturing sector**.**

Table 1. Industry sector 4.0 Ministry of Industry

No	Sector
1	Food and beverage
2	Textiles and clothing
3	Automotive
4	Chemical
5	Electronics
6	Pharmaceutical
7	Medical Devices

The Ministry of Industry made major changes to the entire manufacturing sector by improving company performance through automation technology. This change began by implementing Industry 4.0 to 10 pilot companies selected by the Ministry of Industry. The goal is to make the national manufacturing industry more competitive and support readiness for transformation into the digital and automation era. The selected company is expected to become a national identity on the world stage. The ten companies are PT Niramas Utama, PT Globalindo, Suzuki Indomobil, PT Paragon Technology and Innovation PT Sunindo Adipersada, PT Dharma Precision Tools, PT Sanken, Nutrifood, PT Belindo International Carpet and PT Biggy Cemerlang. The Industrial Revolution 4.0 has been implemented in Indonesia since 2019 to all companies in Indonesia. The development of I4.0 is always been updated until now. Industry 4.0 can provide opportunities for companies to be more effective, efficient and have high productivity. The company can quickly and accurately control the results of its production so that if there is a process deviation, it can be immediately detected and corrective action taken.

Quality 4.0 provides an advantage for organizations to analyze the root causes of problems that arise in business processes. Quality 4.0 provides success in quality aspects and is involved in strategic planning to improve and develop modern technology and the benefits it offers. The benefits obtained include increased data transparency and high-quality data-based insights, which can be maximized to achieve a superior and competitive company. Quality 4.0 prioritizes real-time based data. This data includes the sharing of devices that are connected by all aspects and affect the continuous improvement of quality professionals. One of the most prominent activities is quality improvement which provides great benefits on quality cost efficiency. Quality costs are additional costs incurred to prevent the product from being not good. Experienced and qualified experts can control and provide recommendations for improvement. Industrial Technology 4.0 has a significant impact to continue to push the manufacturing industry into digital transformation. Data quality and data sharing systems that work together will have major effects on quality management, from increasing the speed of

improvement and lowering quality costs to driving skill change. Qualified experts need to hone their skills and incorporate these updates into their workflows to stay competitive [3].

The concept of Quality 4.0 is how to improve quality by integrating intelligent technology and automation. This concept is carried out so that the organization achieves excellence in all aspects including quality and cost. The key element of Quality 4.0 is fast and interactive data processing so that it is able to make fast decisions with consistent time [4]. Connectivity in Quality 4.0 means connections that refer to business Information Technology (IT) and Operational Technology (OT). Basically IT refers to a system such as an enterprise quality management system, a human resource planning management system, and a product life cycle management system, while OT is a technology used in a manufacturing environment. The technology includes service-based and sensitivity-based devices. In addition, the technology applied also contains sensors. Through sensors, all devices can connect with the product (e.g. provide performance feedback across their entire lifecycle), edge devices (which can perform local analytics without burdening the central OT system) and processes in general [5]. Connectivity is able to collect data and process it in real time with a fast response. Enterprise quality management system (EQMS) software is believed to assist management organizations in developing and streamlining quality management systems to improve compliance and improve process efficiency [6].

Important elements of quality 4.0 include people, processes and technology. The first step in any serious work process and the culture in it [4]. It is necessary to consider quality as a strategic business initiative, but not as an operational function. For this purpose manufacturers must understand why quality is important. It is important to reveal critical points and weak points, to attract all those who are interested in them and to establish measurable results [3]. The next stage is related to process integration and optimization to provide a seamless process flow between different functions and systems. This requires the creation of a technology stack as well as a quality command to implement this process. Having created the basis for a successful quality assurance program, the company can use it for all product life cycles and the supply chain ecosystem strictly to support and exceed quality standards[7]. Only 37% of organizations believe that quality is critical to customer satisfaction, 26% agree that the quality function has a clear and compelling role in conveying company strategy, while only 13% say that quality is a priority for top management [8]. Quality 4.0 is an important component of the Industry 4.0 concept which forces companies to pay more attention to quality, Understand what role can be played in the company's success, no need to look further at what impact it has on manufacturers and if there is a recall of defective products in terms of financial losses, image reduction, brand reputation, time and resources needed to improve it [6].

The plastic packaging industry is in the downstream industry category in the food and beverage industry sector because packaging plays an important role in maintaining the quality of the food and beverages produced so that it becomes more hygienic and durable. Plastic packaging products demand stricter specifications than plastic products in general because the packaging is used customers to fill their products such as chocolate, margarine, ice, jam etc. For this reason, the product must be produced in a special room (clean room) and closely monitored until the product reaches the customer [9]. Of course, the production process needs to be controlled so that there are not too many rejects that can reduce the company's efficiency. Packaging is a container or place used to package a product that is equipped with writing, labels, other information explaining the contents, uses and other information that needs to be conveyed to consumers [10]. The history of packaging development along with human civilization. Starting from packaging Traditional: Bamboo, Leaves, Pottery. Over time, there have been many changes in society in the use of packaging that uses paper, glass, metal

and plastic [11]. The following of the use of plastic in Indonesia is also still low compared to other countries can be seen in Figure 1.

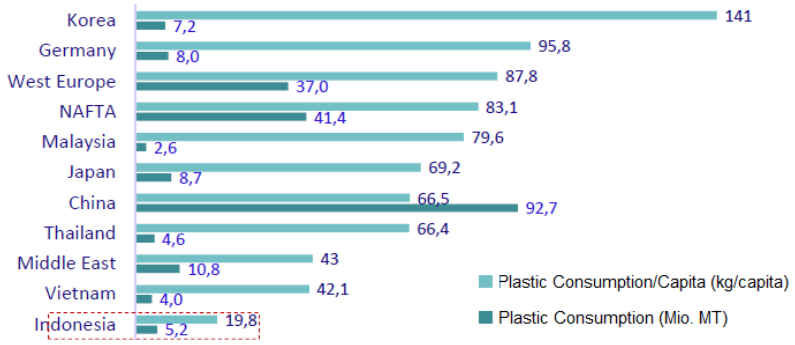

Fig. 1. Per Capita Plastic Consumption in Indonesia
Source: Euromap, BPS import and internal INAPLAS 2018

In the current conditions in the midst of very tight competition, especially in the plastic packaging industry, companies must be able to make concrete innovations [12]. Many companies can no longer supply packaging products because of the tight specs that customers want. Several companies that can supply packaging products are also faced with the condition of many complaints because customers are not satisfied with the quality of the products provided. Innovations that can be done are by implementing industry 4.0, especially quality 4.0 in the process of making packaging products The following of customer complaint January 2019 - September 2021 can be seen in Figure 2.

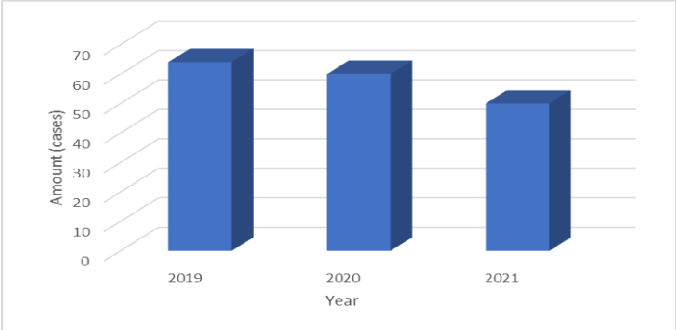

Fig. 2. Graphics of Customer Complaint January 2019 - September 2021
Source: International Packaging Federation 2021

Based on the phenomenon of the application of industry 4.0 which has not yet been implemented in every industrial sector, it is necessary to implement industry 4.0 more evenly and thoroughly. One part of industry 4.0 is the application of quality 4.0, especially in terms of customer satisfaction, how quality 4.0 can control from the beginning to the end of production so that it can produce plastic packaging products that are in accordance with customer wishes. The plastic packaging industry is growing and a lot of new companies are emerging which are increasing competition in the business

world. For this reason, more concrete innovations are needed to face these challenges. The purpose of this study is to see the effect of implementing quality 4.0 on customer complaints that occur.

2 Literature Review

2.1 Industry 4.0

So far, there is no conceptual, operative, or universally accepted definition of Industry 4.0 for the following reasons: Firstly, Industry 4.0 consists of around more than 1200 supporting technologies, furthermore, its innovations are rapidly becoming obsolete, applicable across multiple domains , such as smart factory, city, power grid, health application, house, space, object, or machine and various disciplines have analyzed the subject, such as engineering, economics, and management [13]. Expression of Industry 4.0 ultimately involves the adoption of industrial automation systems that help in managing value and supply chains, and more broadly managing all related processes [14].

Two key factors for the success of Industry 4.0 are integration and interoperability. Integrating industrial automation systems, such as the Cyber Physical System (CPS) and Cyber Physical Production System (CPPS), results in larger and more innovative features through networking with stakeholders, both horizontally as well as vertically. It also helps create connections between virtual and physical worlds. In addition, interoperability facilitates production processes, even without continuity, within and outside business boundaries to link systems and exchange knowledge and skills [15]. Industry 4.0 Opportunities can be classified into six main typologies: production flexibility, which occurs during small lots, serial prototyping speed, greater output capacity, reduced setup costs and fewer machine errors and downtime, higher product quality and production fewer are rejected; and increasing customer opinion of the product [16]. Industry 4.0 refers to the integration of the multiplicity of technologies and agents for the common goal of increasing the efficiency and responsiveness of the production system. This integration has the potential to revolutionize the way businesses are planned and run. Smart Manufacturing represents the implementation of Industry 4.0 on the manufacturing floor. Internet of Things, Big Data, Cyber Physical Systems, Machine Learning, Additive Manufacturing, and Robotics are just some of the elements associated with this revolution [17].

2.2 Quality 4.0

Quality 4.0 is in line with the increasingly digitalization of the industry, which uses advanced technology to improve the quality of manufacturing and services. This fourth quality revolution is intended to digitize the entire quality system and further improve existing quality approaches. Innovative industries adopt cloud-based 4.0 quality innovations in controlled production processes. It is used to satisfactorily resolve quality issues as they arise and perform real-time quality analysis to improve competitiveness and use them. Various ongoing challenges are taken over by Quality 4.0 technology, such as automated root cause analysis, machine-to-machine connectivity to automatic adjustment of parameters, real-time process simulation, and much more [7]. Quality 4.0 is a modern form of quality management. Digital technology paired with more sophisticated methods and smarter processes will enable high-performance teams to reliably deliver high-performance and quality goods to consumers.

Sensors play an important role in improving the quality of manufacturing and service. These can improve protection, increase internal productivity and continuous operation. Quality 4.0 will have a significant impact in manufacturing. Various Key Aspects and enablers of Quality 4.0 for Manufacturing are discussed, finally, Identify and discuss eighteen significant applications of Quality 4.0 in manufacturing. Quality 4.0 doesn't just concern what happens inside the factory; it also covers a complete supply chain from Research and Development (R&D), manufacturing, development, distribution, sales, and after-sales service [3].

3 Methodology

The study uses a systematic stage. The following flow can be seen in Figure3. In this research methodology, it can be used as a guide in conducting analysis and application to produce plastic packaging products that comply with specifications and also reduce customer complaints. Industry 4.0 currently available must be used optimally to be able to present accurate and real time data, so that analysis can be carried out quickly and precisely. Material system that anticipates material use errors. Clean room conditions designed to eliminate potential foreign materials, strict process control on the dashboard to be able to suppress existing rejects as well as several other requirements such as ISO 9001: 2015, ISO 22000, Sedex and Halal Assurance System enable companies to fulfill current demands and be able to find new customers in order to increase the company's turnover and profit. Plastic packaging products do have strict specifications because these products are used in food and beverages that are consumed directly by consumers so they must be really hygienic. The stages of the process described above are ways that must be taken to get quality products, high productivity and can meet the expectations of consumers. The following of the stages carried out from the beginning to the end of the research

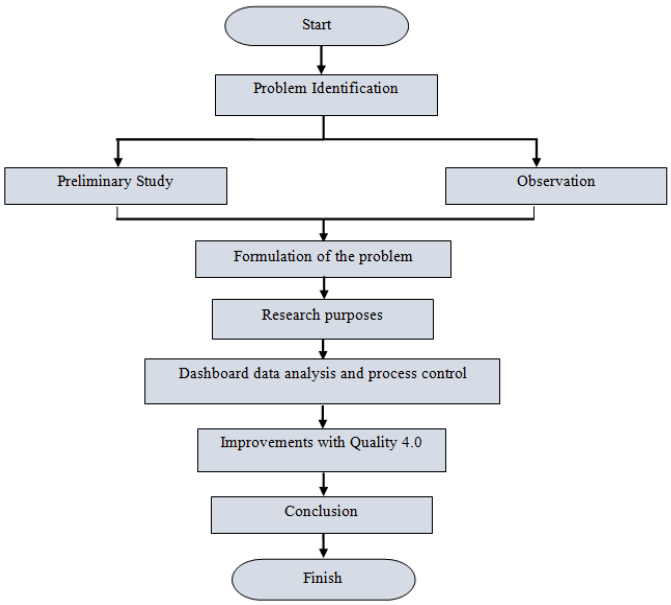

Fig. 3. Research Flowchart

4 Result and Discussion

4.1 Quality 4.0 Implementation

The application of industry 4.0 is carried out in stages at all levels, both operational and office. This is due to limitations in terms of investment. The Figure 4 is application of the industry 4.0 model in quality and factory. With the use of an integrated system, it will be easier to control each process so that fast and precise steps can be taken regarding process deviations. This is in accordance with the concept of Quality 4.0 which is mutually integrated between systems. The figure 5 is Quality 4.0 for reject control during production.

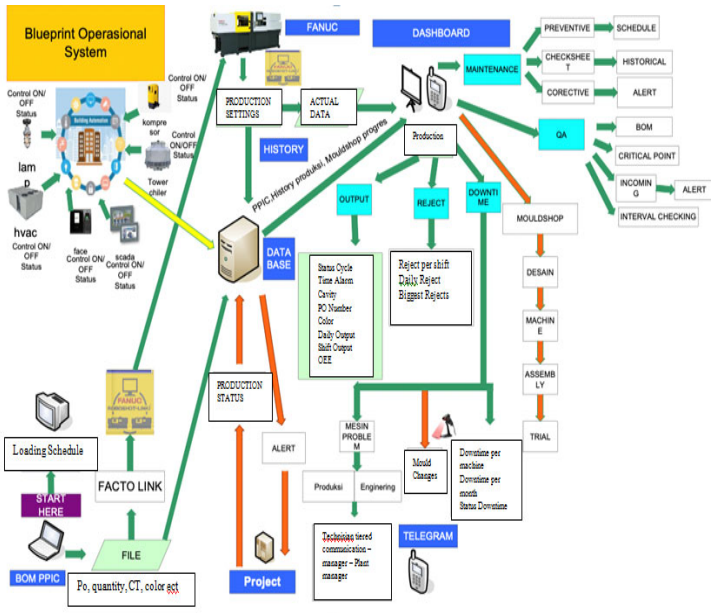

Fig. 4. Blueprint Operational System

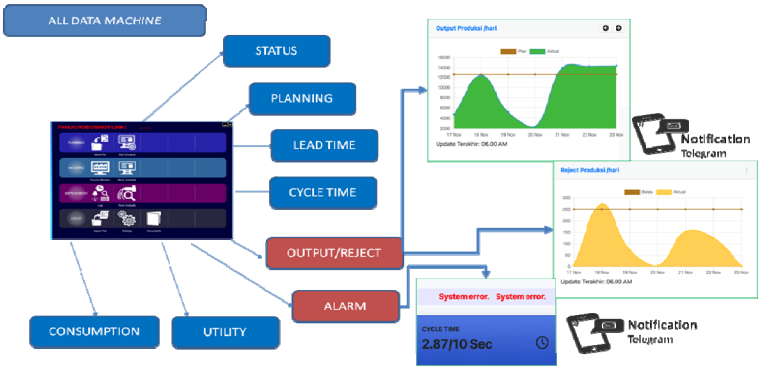

Fig. 5. Implementation Quality 4.0

Data from machines that have been identified as good or not are transferred to big data then the data is processed into a dashboard display and can be accessed on mobile phones anywhere and anytime, this can monitor rejects that occur and take preventive measures in the future from available data trends. The figure 6 is Quality process so that the condition of the room is maintained and the system material can run optimally.

Fig. 6. Building Automatitation System for Quality Process

Incoming Materials, The material receipt process begins with information obtained from purchasing regarding the material arrival schedule, then the incoming material is checked by the QC section (checks include appearance, color, dimensions, odor) according to the product criteria to be checked and complete data such as Certificate Of Analysis (COA) Technical Data Sheet (TDS), statement letter related to food grade and product halalness. If the product is declared OK, it is immediately stored in the warehouse in accordance with storage standards, if it is Not Good (NG) then it is immediately returned and a complaint is made to the supplier. All transactions, reports can be made and obtained directly on the dashboard and there are notifications regarding this. Process Control, the following steps are taken to carry out a strict control process, material system to avoid product mix-ups, errors in product use, product hygiene and ease of processing, a material system is used where all raw materials are put into 3 silos (block, homo, random). Later, from each silo, the product will be withdrawn to meet the needs of each production machine. Silos are equipped with sensors that can detect which material is being pulled. The results of the use of raw materials from each can be directly seen in the control room. Clean room is a sterile room used for the production of packaging products with strict specifications. This room is equipped with checking humidity, temperature, a room that pushes dirt out. The machine used is also very clean and the use of environmentally friendly oil. This room is carried out 5R every shift so that it is more clean. People who enter the room are also equipped with standardized Personal Protective Equipment (PPE) so that only certain and limited people can enter.

Most of the products produced in this room are packaging products. The work is done with robots and the use of sensors so that it is semi-automated. Products that come out of this room are already packaged so that they just need to be brought and stored in the warehouse, Check Interval In the initial process of the product run (First Run) from QC, Production, Moldshop and Engineering are involved in the process to ensure that the running product has no quality problems, the mold is suitable for use, the machine has no problems and the operator is available on the machine. If OK, the data from the first run is notified to the new system, the product can run, if it is Not Good (NG), further improvements will be made. Check intervals are also carried out by QC personnel every 2 hours by looking at the appearance and suitability of the color of the product, if reject > 2% then there will be a notification so that repairs can be done on the machine and the problematic product. The results of the check

interval are inputted on the dashboard, Lab interval Functionally and dimensionally tested in the lab, functionally tested products such as leaking test, fitting test, drop test, Product improvement When the product is running, a Failure Mode Effect Analysis FMEA is made from the project to identify and anticipate product failure factors. If high rejects are found, a Quality Control Group (QCC) will be made, Dashboard The data on the dashboard is presented in real time directly from the production machine, the data is immediately made a resume / graph as needed, the data can be accessed anywhere and anytime. This is very helpful in improving the production process. Outgoing Products Products to be sent are checked by QC in accordance with established standards. Products that are suitable are directly attached to the barcode by the production and the product is directly checked by the QC. If the product is OK, the product will be QC Stamp equipped with the identity of the inspector. The product is made a travel document and sent to the warehouse to be stored and allocated according to customer requests. The steps taken from incoming, processing and outgoing which are strictly controlled can reduce customer complaints. The Figure 7 is Customer complaints after the implementation of quality 4.0 is decreasing.

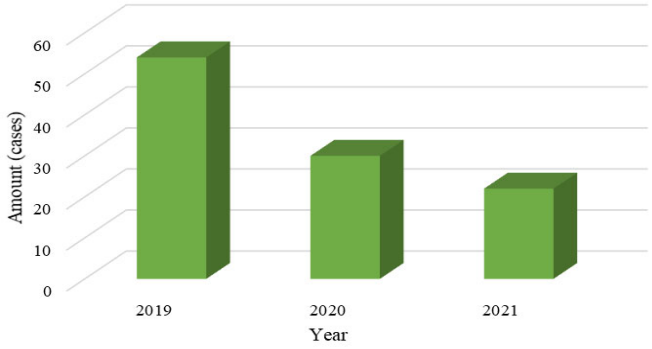

Fig. 7. Graphics of Customer Complaint January 2019 - October 2021
Source: Customer complaint PT. X 2019 – 2021

4.2 Practical Implication

The application of Quality 4.0 in the industry, especially in packaging products, is needed because the specifications requested from customers are very high. A sterile and controlled process is required from start to finish. Through Quality 4.0, process discrepancies can be detected immediately so as not to cause an increase in reject products. Based on improvements with real time and accurate data, corrective actions can be taken to correct and prevent abnormal production. An integrated system that allows each department to focus on and support the quality of the products produced. Quality management needs to be improved with the main goal of empowering Quality 4.0 as much as possible to get maximum results. The packaging industry always aims to improve quality and productivity as a measure of the success of a company. Future production must require more advanced breakthroughs to always be able to take advantage of technology that can produce quality products.

4.3 Discussion with Previous Research

Quality improvement by implementing Quality 4.0 can reduce customer complaints which have an impact on increasing company performance. Based on these results the company gets

economic benefits which are measured in quality improvement. The results of this study are in line with the research of Carvalho et al (2021), implementing Quality 4.0 can reduce the rate of customer complaints. This research is also in line with Fonseca et al (2021), that Quality 4.0 is also able to increase company performance. Most of the manufacturing industry is troubled with low quality which has an impact on the loss of customer satisfaction. Based on the research of T. Kurfess (2018), to remain consistent the Quality 4.0 application requires improvements that are supported by top management.

5 Conclusion

The purpose of this study is to see the effect of implementing quality 4.0 on customer complaints. This research begins with the phenomenon of problems that occur in the Manufacturing Industry. Complaints from customers are very high so it needs to be repaired. Some of the factors that cause product packaging not to suit the customer's wishes because the appearance and functionality of products that do not match can be corrected by implementing quality 4.0 with a clean room and strict process control. The implementation of quality 4.0 can reduce customer complaints by 44% in 2020 and 27% in 2021. The limitations of this study indicate that the high cost of investment is the biggest obstacle to implementation. These obstacle factors can be considered for further research in determining strategic suggestions for the implementation of industry 4.0 in the manufacturing industry in Indonesia.

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